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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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EXAMINER

KIELIN, ERIK J

ART UNIT	PAPER NUMBER
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2813

DATE MAILED: 01/11/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

09/296,835

Applicant(s)

WEIMER ET AL.

Examiner

Erik Kielin

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 26 October 2004.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 2-5, 8, 11, 12, 42 and 44 is/are pending in the application.
- 4a) Of the above claim(s) none is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 2-5, 8, 11, 12, 42 and 44 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date _____
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____

DETAILED ACTION

This action responds to the Amendment filed 26 October 2004.

Claim Rejections - 35 USC § 112

1. The following is a quotation of the first paragraph of 35 U.S.C. 112:

The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

2. Claims 8, 2-5, 11, and 12 are rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the enablement requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention.

Claim 8 requires the pressure in the chamber to be “held at about atmospheric pressure.” First nowhere in the specification is it stated that the pressure is “held at about atmospheric pressure.” Second and more importantly, this limitation is not enabled because the specification fails to indicate how the wet oxidation would be carried out using *in situ* reaction of hydrogen and oxygen at a pressure of about 1 atmosphere. The pressure of about 1 atmosphere **cannot** be maintained because there will necessarily be an explosion/detonation under the conditions presently disclosed. Rationale follows.

Given the claimed ratio of hydrogen to oxygen claimed to be 0.1 to 0.8 (that is the equivalent of 90 mol% O₂ in H₂ down to 10 mol% O₂ in H₂) and, as stated in the **specification at p. 8, lines 13-25**, that the ratio of steam to other gases is preferably 0.1 to 0.5 when such H₂ - O₂ mixture is used. Given the stoichiometry of the reaction between hydrogen and oxygen to form

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water: $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$, the concentration of hydrogen must be 0.1 or 10% (or 76 Torr at the claimed 1 atmosphere [760Torr] of pressure) relative to the other gases, in order to produce steam in a ratio of 0.1 relative to the other gases. The explosion concentration limits for hydrogen in air are 4.1% to 74.2%. (See Appendix A: obtained from

<http://toxnet.nlm.nih.gov/cgi-bin/sis/search> which has the explosion limits for hydrogen in air.)

Accordingly, there will **necessarily be an explosion** in the entire disclosed preferred range of 0.1 to 0.5 steam to other gases, disclosed in the instant specification. Fig. 7 of Miner shows that the detonation of hydrogen with oxygen **increases** the pressure. In the examples shown in Fig. 7, shows that 10% hydrogen (the 90% oxygen in the horizontal axis) only 15 Torr lead to an increase in pressure of 0.5 atm (380 Torr) that is a 380/15-fold or about 25-fold increase in pressure. Accordingly, the pressure presently claimed would far exceed 1 atmosphere.

Further in this regard, the instant specification at p. 9, lines 2-5 teaches away from such high pressures when H_2 and O_2 mixtures are used to generate the steam, stating,

“In general, the pressure can be at about atmospheric pressure, although if the H_2 and O_2 gases are combined in the chamber 50, then **the pressure should be kept lower, for example, around 1 millitorr.**”
(Emphasis added.)

This pressure is 0.001 Torr. It begs the question as to why, now Applicant would claim that the pressure should be 760 Torr (1 atm), or 760,000 times the pressure indicated in the specification.

Still further in this regard, given the above indicated stoichiometry in the reaction between hydrogen and oxygen to produce water, 3 molecules combine to form two which necessarily reduces the pressure. This combined with the additional fact that the specification fails to address this and how the wet oxidation could be held at atmospheric pressure and teaches away from atmospheric pressure use if hydrogen and oxygen are reacted *in situ*, leads to the

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overwhelming lack of enablement of this feature and lack of written description. One of ordinary skill could simply not perform the method as claimed in claim 8 given the original disclosure.

Accordingly claim 8 is not enabled because specification fails to provide conditions capable of using an explosive mixture of H₂ and O₂ gases that could somehow be maintained at 1 atmosphere of pressure, given the above evidence.

While claim 5 depends from claim 8, claim 5 possesses a similar problem because it requires the ratio of hydrogen to oxygen to be 0.1 to 0.5, which is also in the explosive range.

The remaining claims are rejected for depending from rejected claim 8.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

4. Claims 8, 2-4, 11, 12, 42, and 44 are rejected under 35 U.S.C. 103(a) as being unpatentable over US 5,374,578 (**Patel et al.**) in view of US 6,066,581 (**Chivukula et al.**) and further in view of **Van Zant**, (Microchip Fabrication. A Practical Guide to Semiconductor Processing, 3rd ed. McGraw-Hill: New York, 1997, pp. 157-160).

Regarding independent claims 8, 42, and 44, **Patel** discloses a method of fabricating a semiconductor device comprising,

depositing an oxygen deficient dielectric ferroelectric film **14** (Figs. 2-6) such as PZT, which inherently has a dielectric constant of greater than 25 (see Chivukula col. 16, lines 34-38) over a semiconductor substrate **8** of Si or GaAs (Patel, col. 3, lines 12-13);

subjecting the dielectric film **14** to a densifying treatment to stabilize said film by heating said semiconductor substrate **8** (col. 3, lines 59-62; note that removal of the organic solvents necessarily densifies the dielectric film because the organic solvents removed are necessarily less dense than PZT, thereby leaving behind a condensed, more dense PZT film);

subjecting the dielectric film **14** to an annealing in ozone using RTA (which must necessarily occur, then, in an RTA chamber --as further limited by instant claim 12) at a temperature range of 650 °C - 850°C for about 5-30 seconds (in one example) in order to increase the oxygen content of the ferroelectric film (column 2, lines 30-33), wherein **any pressure** may be used (col. 4, lines 24-27) during the annealing, which reads on pressures in the range from 0.001 Torr to less than 760 Torr (atmospheric pressure);

and performing a stabilizing treatment using oxygen in the RTA chamber --as further limited by instant claim 12-- in one embodiment, after the ozone anneal (column 4, lines 23-38).

Patel does not teach using wet oxidation during the ozone anneal.

Chivukula also teaches forming an oxygen deficient ferroelectric material such as PZT using a sol-gel method just as does **Patel**; subjecting the dielectric film to a wet oxidation using a mixture comprising **water** and **ozone** at a temperature of 450-800°C in a rapid thermal annealing (RTA) chamber for 30 seconds to several minutes to form uniform grain sizes in the ferroelectric material in a shorter time, at reduced temperature and superior characteristics during high

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frequency use compared to using dry oxidation (column 14, lines 27-48) and also to reduce the stress in the ferroelectric film (col. 15, lines 41-43). (See also column 13, lines 30-53.)

It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate water during the ozone anneal of **Patel** for the reasons indicated in **Chivukula**, as just noted.

Then the only difference is that **Chivukula** does not indicate that the water is provided by reaction of hydrogen with oxygen in a ratio of 0.1 to 0.8 or 0.1 to 0.5 (as presently required in claim 5). Instead, **Chivukula** teaches using a bubbler. **Chivukula** does teach

“Water vapour was conveniently introduced into the annealing atmosphere of the rapid thermal anneal (RTA) system during the annealing of the PZT by passing oxygen (O₂) through a double bubbler containing purified deionized water, so that the oxygen was saturated with water vapour, e.g. using a gas flow rate of about 2 L/min.” (Chivukula, col. 13, lines 40-46).

Van Zant teaches that “Dryox,” a mixture of hydrogen and oxygen gases which react to form a steam oxidizing mixture in the reactor, is preferred over liquid systems such as a bubbler, because the process is cleaner and more controllable and also that “Dryox is the preferred method for production of advanced devices.” (See pp. 157-160 -- especially page 160.)

It would have been obvious to one of ordinary skill in the art at the time the invention was made to use hydrogen and oxygen as taught by **Van Zant** to form the steam for the wet oxidation mixture of **Chivukula**, for the reasons indicated in **Van Zant**, as noted, and especially because “Dryox” is preferred to bubblers which **Chivukula** uses.

Furthermore, the method by which the water for the wet oxidizing atmosphere is not critical according to Applicant's admissions in the instant specification. Rather, Applicant's specification teaches away from such unexpected results. Applicant teaches,

“One of several techniques can be used to provide steam to a vicinity of the insulating film. Such techniques include using a **bubbled water vapor system**, a **pyrogenic system** or a **catalytic system**, or **generating steam in the chamber *in situ***.” (Emphasis added. See instant specification, page 3, lines 13-17.)

In other words, any of the presently notoriously well-known means to form the steam, which are specifically used in the art for oxidation, could be used, according to Applicant. Also note that the paragraph bridging pages 7 and 8 of Applicant’s specification indicates specifically that a bubbler can be used in the instant invention.

Then the only difference is that the ratio of hydrogen to oxygen is not taught in **Chivukula**. However, **Chivukula** indicates that the wet oxidation is carried out in water plus oxygen and ozone (**Chivukula** at col. 13, lines 36-46). “[I]n considering the disclosure of a reference, it is proper to take into account not only specific teachings of the reference but also the inferences which one skilled in the art would reasonably be expected to draw therefrom.” *In re Preda*, 401 F.2d 825, 826, 159 USPQ 342, 344 (CCPA 1968) See also *In re Lamberti*, 545 F.2d 747, 750, 192 USPQ 278, 280 (CCPA 1976). With this in mind, because **Chivukula** teaches that oxygen must be in excess of the water vapor, one of ordinary skill would know, based upon the stoichiometry of the reaction between hydrogen and oxygen to form the “Dryox” mixture containing water (as taught by **Van Zant**) that the ratio of hydrogen to oxygen must necessarily be less than or equal to about 0.67 because hydrogen reacts with oxygen in a 2 to 1 stoichiometric ratio ($2 \text{ H}_2 + \text{O}_2 \rightarrow 2 \text{ H}_2\text{O}$). Otherwise, the oxygen will be depleted in the formation of water and excess hydrogen would remain, contrary to the teaching in **Chivukula**. Accordingly, one of ordinary skill would clearly recognize that using the more desirable method of “Dryox” oxidation, as taught by **Van Zant**, would necessarily require a range hydrogen to

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oxygen of 0.67 or less in order to achieve the mixture taught by **Chivukula** which requires excess oxygen with the water, which overlaps the claimed ratio of 0.1 to 0.8, and 0.1 to 0.5.

Regarding claims 2-4, although **Patel** does not recite Applicant's exact ranges of either 450-750°C or 750-900°C or exact times of 20-60 seconds for the oxidation, **Patel** does disclose an overlapping temperature range of 650-850 °C and time range of 5-30 seconds, in at least one example. **Chivukula** also teaches 30 seconds to several minutes annealing time, which temperature and material dependent. These claims are *prima facie* obvious without showing that the claimed ranges achieve unexpected results relative to the prior art range. *In re Woodruf*, 16 USPQ2d 1935, 1937 (Fed. Cir. 1990). See also *In re Aller*, 105 USPQ 233 (CCPA 1955) (selection of optimum ranges within prior art general conditions is obvious).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to optimize the temperature and anneal time to provide the best ferroelectric film, according to the precedent above.

Regarding claim 11, **Patel** does not teach performing the ozone oxidizing or the oxygen stabilizing treatments at different temperatures, **Chivukula** teaches that the addition of water vapor reduces the densification/crystallization temperature from dry conditions.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to perform the wet ozone anneal of **Patel** at a lower temperature than the oxygen stabilizing anneal because each of **Emesh** and **Chivukula** teaches a lower temperature may be used for wet versus dry oxidation.

Further regarding claims 8 and 44, while no specific pressure, nor pressures of 1 atmosphere (claim 8) or 1 milliTorr (claim 43) are taught in **Patel** or **Chivukula**, the pressure is

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a matter of routine optimization. The selection of the 1 milliTorr or 1 atmosphere is obvious because it is a matter of determining optimum process condition by routine experimentation with a limited number of species. See *In re Jones*, 162 USPQ 224 (CCPA 1955)(the selection of optimum ranges within prior art general conditions is obvious) and *In re Boesch*, 205 USPQ 215 (CCPA 1980)(discovery of optimum value of result effective variable in a known process is obvious). Currently, there exists no criticality of the pressure to the practice of the instant invention since pressures as low as 1 milliTorr (0.001 Torr) and about 760 Torr can be used, according to the instant specification. One of ordinary skill in the art would be motivated to use low pressures of hydrogen and oxygen, at least to prevent explosion.

5. Claim 42 is rejected under 35 U.S.C. 103(a) as being unpatentable over US 6,066,581 (Chivukula et al.) in view of the excerpt from the basic textbook of Van Zant, Microchip Fabrication, A Practical Guide to Semiconductor Processing, 3rd ed. McGraw-Hill: New York, 1997, pp. 157-160.

Chivukula discloses a method of fabricating a semiconductor device comprising the steps of

depositing a dielectric film (specifically PZT, a ferroelectric film which inherently has a dielectric constant of at least 25) over a semiconductor substrate to form a capacitor dielectric;

subjecting the dielectric film to a densifying treatment to stabilize said dielectric film by heating the semiconductor substrate at 100 °C and then again at 350-400 °C, which removes volatile organic components prior to performing the wet oxidation on the stabilized PZT dielectric film; and

subjecting the stabilized dielectric film to a wet oxidation with steam process using a mixture comprising water, oxygen, and optionally ozone at a temperature of 450 °C to 800 °C in a rapid thermal annealing (RTA) chamber for 30 seconds to several minutes to form uniform grain sizes in the ferroelectric material in a shorter time, at reduced temperature and superior characteristics during high frequency use compared to using dry oxidation and which inherently raises the oxygen content of the dielectric film (column 14, lines 27-48). (See also col. 12, lines 12-38 and col. 13, lines 5-53. See MPEP 2112.)

Chivukula does not teach that the water is provided by reacting hydrogen and oxygen to produce steam, but does teach that

“Water vapour was conveniently introduced into the annealing atmosphere of the rapid thermal anneal (RTA) system during the annealing of the PZT by passing oxygen (O₂) through a double bubbler containing purified deionized water, so that the oxygen was saturated with water vapour, e.g. using a gas flow rate of about 2 L/min.” (Chivukula, col. 13, lines 40-46).

Van Zant teaches that “Dryox,” a mixture of hydrogen and oxygen gases which react to form a steam oxidizing mixture in the reactor, is preferred over liquid systems such as a bubbler, because the process is cleaner and more controllable and also that “Dryox is the preferred method for production of advanced devices.” (See pp. 157-160 -- especially page 160.)

It would have been obvious to one of ordinary skill in the art at the time the invention was made to use hydrogen and oxygen as taught by **Van Zant** to form the steam for the wet oxidation mixture of **Chivukula**, for the reasons indicated in **Van Zant**, as noted, and especially because “Dryox” is preferred to bubblers which **Chivukula** uses.

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Furthermore, the method by which the water for the wet oxidizing atmosphere is not critical according to Applicant's admissions in the instant specification. Rather, Applicant's specification teaches away from such unexpected results. Applicant teaches,

“One of several techniques can be used to provide steam to a vicinity of the insulating film. Such techniques include using a **bubbled water vapor system**, a **pyrogenic system** or a **catalytic system**, or **generating steam in the chamber *in situ***.” (Emphasis added. See instant specification, page 3, lines 13-17.)

In other words, any of the presently notoriously well-known means to form the steam, which are specifically used in the art for oxidation, could be used, according to Applicant. Also note that the paragraph bridging pages 7 and 8 of Applicant's specification indicates specifically that a bubbler can be used in the instant invention.

Response to Arguments

6. Applicant's arguments filed 26 October 2004 have been fully considered but they are not persuasive.

Applicant argues that Patel does not teach a densifying treatment. Examiner respectfully disagrees. Patel discloses this at col. 3, lines 59-62.

Applicant also argues that Patel does not teach holding the RTA chamber at atmospheric pressure. Examiner respectfully disagrees. While this limitation is not enabled in the instant specification, Patel says that any pressure may be used at (col. 4, lines 24-27) which reads on any pressure used in the instant application, as there exists no evidence of criticality of the instant pressure and that the instant specification teaches away from any such criticality, as already noted in the rejection of the claims.

Applicant also argues that Patel does not teach holding the RTA chamber at 1 milliTorr pressure. Examiner respectfully disagrees. Patel says that any pressure may be used at (col. 4, lines 24-27) which reads on any pressure used in the instant application, as there exists no evidence of criticality of the instant pressure and that the instant specification teaches away from any such criticality, as already noted in the rejection of the claims.

In response to applicant's argument that there is no suggestion to combine the references, the examiner recognizes that obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either in the references themselves or in the knowledge generally available to one of ordinary skill in the art. See *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988) and *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992). In this case, the reasons for the combination are as stated in the rejection above.

Applicant argues that the temperatures used in Patel and Chivukula are different but they are, in fact, **not** different. Patel uses temperatures of 650 to 850 °C (col. 4, lines 11-14) while Chivukula teaches temperatures of 450 to 800 °C --specifically using 650 to 850 °C for PZT, just as does Patel (**Chivukula col. 23, lines 3-21**). While Chivukula may achieves lower temperatures anneals using water but also shows that higher temperatures give higher dielectric constants which are desired so long as materials previously deposited permit. (See also Chivukula at col. 12, lines 12-38; col. 16, lines 34-38.)

Applicant suggests that the references of Patel and Chivukula have "little in common." Examiner respectfully but emphatically disagrees. Each reference is drawn to forming high dielectric constant materials using a sol gel method for capacitors in semiconductor memory

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devices. Each addresses specific examples using PZT. Accordingly, this argument is wholly without merit for ignoring that fact each reference is drawn to the very same endeavor.

Conclusion

7. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).


A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Erik Kielin whose telephone number is 571-272-1693. The examiner can normally be reached on 9:00 - 19:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead, Jr. can be reached on 571-272-1702. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).



Erik Kielin

Primary Examiner

January 9, 2005